DECIMAL

COINAGE, WEIGHTS AND MEASURES

POPULARLY EXPLAINED

BY

SIR GUILFORD MOLESWORTH, K.C.I.E.

Consulting Engineer of the Government of India for State Railways,

AND

MR. J. EMERSON DOWSON, M.Inst.C.E.

REVISED AND ISSUED BY THE DECIMAL ASSOCIATION,

BOTOLPH HOUSE, EASTCHEAP, LONDON, E.C.

(KENRIC B. MURRAY, *Secretary.*)

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DECIMAL ASSOCIATION:

(Established to promote the adoption in the United Kingdom of a Decimal System of Currency, Weights and Measures.)

OFFICES AT

THE LONDON CHAMBER OF COMMERCE,

BOTOLPH HOUSE, EASTCHEAP, LONDON, E.C.

PROSPECTUS.

This Association has been formed with a view of increasing the pressure of public opinion, and disseminating knowledge throughout all classes in the United Kingdom, on the advantages to be derived from the adoption of a Decimal System, not only for currency, but also for weights and measures.

No particular Unit has been adopted by the Association for a Decimal Currency.

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All Members are supplied free with the Association's publications.

DECIMAL ASSOCIATION.

(Established to promote the adoption in the United Kingdom, of a Decimal System of Currency, Weights and Measures).

Botolph House, Eastcheap,

Secretary:
KENRIC B. MURRAY.

London, E.C., Dec. 3rd, 1890.

Dear Sir,

I am desired by the Executive Committee of this Association to ask you to be good enough to make known the accompanying pamphlet to the members of your Society.

The subject of decimalising our coinage, weights and measures — particularly the latter — is of growing national importance, and it is hoped that your members will be able to have some discussion upon it.

I may add that the Committee is endeavouring to bring about a new parliamentary inquiry on the subject, and that they are anxious to receive as much general support as possible.

Yours faithfully,

KENRIC B. MURRAY,
Secretary.

To the Secretary of

Decimal Association.

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BOTOLPH HOUSE EASTCHEAP, LONDON, E.C.

THE DECIMAL ASSOCIATION.

BOTOLPH HOUSE,
EASTCHEAP, E.C.

.....189

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I venture to send you a little pamphlet just issued by this Association, and I shall be pleased to know that we may count on your support and co-operation.

May I add that we shall be glad to welcome you as a Member of the Association if you will kindly fill up and return to me the annexed form of application. The annual subscription is only *ten shillings*.

I remain,

Yours faithfully,

KENRIC B. MURRAY,

Secretary.

To .....

.....

[P.T.O.

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INDEX.

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COINAGE, WEIGHTS AND MEASURES

POPULARLY EXPLAINED.

[*In preparing this pamphlet it has been thought best to condense the information as much as possible, under different headings, and to relegate to Appendices all examples and evidence in support of the statements put forward.*]

1. Decimal Notation.

The counting by tens is no doubt due to the simple fact that human beings have 10 fingers, and that primarily they were used as the means of computation. Some contend that a system based on 8 or 12 would be better, but the fact remains that throughout the civilised world a decimal system of notation has been adopted, that it forms the basis of the world's arithmetic, and cannot now be changed, even if it were desirable. Seeing, therefore, that we are committed to a decimal system of notation, it naturally follows that we should also reckon our coinage, weights and measures on a decimal basis.

The history of arithmetic shows that the three great periods of progress in computation have been :—

1st—The adoption of a decimal notation which superseded the cumbrous Greek and Latin notation.

2nd—The introduction of decimal fractions ; and

3rd—The invention of logarithms, which, as at present used, are entirely dependent on decimals.

(See Appendix I.)

2. Popular Objections to Decimals.

The number 10 is not divisible by certain numbers, as for instance by 3, without remainder, and it is sometimes urged that this is a fatal objection to the use of a decimal system. The advantage, however, of having a system of weights, measures and coinage in unison with the basis of notation far out-weighs the objection which has been raised. It is, moreover, a mistake to suppose that if such a system were generally adopted, vulgar fractions must in no case be used. Decimals are not upheld as exclusively right, and when in certain cases it is quicker or more accurate to use vulgar fractions, undoubtedly they should be used. No system is best under *all* circumstances, and from a practical point of view we have to select that which presents the greatest number of advantages, and it is reassuring to know that in all the countries where a decimal system of coinage or weights and measures has been adopted, no practical difficulty has been experienced in sub-division. In fact the importance of this dividing without a remainder has been greatly over-rated.

(See Appendix II.)

3. Decimal Fractions.

When there are whole numbers we know that the figures next to the units, on the left side, are to be treated as ten times more than units, that those next to the tens, on the left side, are to be treated as ten times more than the tens, and so on. If we now make a point (.) to the right of the units, and write down more figures to the right of the point, the first will represent a tenth of the unit, the second a hundredth, and so on. In other words the first figures to the left of the point are to be treated as *multiplied*, and those to the right as *divided* by ten or by multiples of ten.

(See Appendix III.)

4. Simplicity of a Decimal System.

A decimal system dispenses with compound arithmetic, and substitutes for it simple arithmetic.

Decimal arithmetic only differs from simple arithmetic in the placing of the decimal point, and the following rules for this can be mastered in a few minutes.

(a) In addition and subtraction, place the decimal points of each set of figures under each other.

(b) In multiplication, point off in the product as many places of decimals as there are both in the multiplier and the multiplicand.

(c) In division, point off in the quotient as many places as those in the dividend exceed those in the divisor.

(See Appendix IV.)

5. Decimals applied to Coinage.

If our coins were made to represent units, tens, and multiples of tens, the whole numbers and fractions could be added, subtracted, multiplied, or divided decimally in the simplest way, as explained in paragraphs 3 and 4. *In every civilised country, except Great Britain and some of her dependencies*, there is now a decimal system of coinage, and in all these countries the addition, subtraction, multiplication and division of money are as easy as with simple numbers. *In no single instance has any country given up a decimal system after once adopting it.*

(See Appendix V.)

6. Disadvantages of present System of Currency.

To add together pounds, shillings and pence, we must first add the farthings (expressed as vulgar fractions) and divide by 4 to reduce them to pence. We must then add the pence and divide by 12; then the shillings and divide by 20; and in each case we must carry forward a number resulting from the reduction. The same may be said for subtraction, but in multiplication and division the difficulties are still greater, and many more figures are usually necessary. In all cases, there is, of course, more labour and much more mental exertion than are expressed by the actual figures set down. In a decimal system neither reductions nor divisions are necessary, and the working is thereby greatly simplified as the examples given in the Appendix forcibly show.

(See Appendix VI.)

7. Decimals applied to Weights and Measures.

If our weights and measures were based on standards divisible by ten, we should be able to reckon by them decimally, as already explained for coinage. At present to add together tons, cwts., qrs. and lbs., we must first add up the lbs. and divide by 28; then the qrs. and divide by 4; then the cwts. and divide by 20; and in each case we must carry forward a number resulting from the reduction. If we

used a ton consisting of 1,000 units, as in France and nearly all other civilised countries, any number of them and any number of fractional parts could be added together as in simple addition.

The same observations apply to measures of length, surface and capacity; and in all cases the addition, subtraction, multiplication and division decimally are as easy as with simple numbers.

(See Appendix VII.)

8. Disadvantages of present Weights and Measures.

We cannot add, subtract, multiply, or divide our present weights or measures without remembering or consulting many inconsistent and incongruous tables. The sub-divisions of these weights and measures are most arbitrary, and as they are not based on any one system of multiples, special reductions are necessary for each sub-division. In the case of weights, there is the further complication that the avoirdupois pound consists of 16 ounces of 437½ grains each, or 7,000 grains, whereas the troy pound has only 12 ounces of 480 grains each, or 5,760 of the same grains. We are thus confronted with the double difficulty of the troy ounce being heavier, while its pound is lighter than the avoirdupois.

The working of an example, which is of an ordinary kind, is given in two ways in the Appendix, and it will be seen that in both ways the number of figures required and the difficulty of avoiding mistakes are really serious. In the second way of working *practice* has been used, as this is shorter than the other, but it should be remembered that *practice* is known to comparatively few, and that with it there are often difficulties in the odd fractions. If such a sum were worked out on a decimal basis it would be quite simple.

(*See Appendix VIII.*)

9. Further reasons for adopting Decimal Weights and Measures.

Apart from the desirability of adopting a rational and convenient system of weights and measures, stands the important fact that *more than 60 per cent. of the foreign trade of Great Britain is with countries in which one and the same decimal system has been adopted.*

We are now in keen competition with manufacturers and merchants in such countries, and some of our Consuls have drawn attention to the loss of trade we sustain owing to the difficulty which foreign dealers experience in understanding our complicated system of coinage, weights and measures.

Amongst scientific men, the Metrical system is invariably used in all countries. Science teachers, whether in Universities or Technical Schools, use it without exception; in the chemical trades it is much used; and electricians throughout the world have adopted it as the basis of a system of electrical units. In fact nearly all work which depends on improved scientific methods renders the employment of a decimal system an absolute necessity.

(*See Appendix IX.*)

10. The Metrical System.

It is only necessary to compare our cumbrous and defective system with the simple and rational one of decimals which has been adopted in France and many other countries, to see the immense superiority of the latter.

Contrast the English system of measuring by inches, feet, links, yards, fathoms, chains, poles, furlongs, miles, perches, roods, acres, pints, quarts, gallons, pecks, bushels, quarters, &c., &c., with the metrical system, which is based on one simple unit only, whether for length, breadth, area, or capacity. With this simple unit and its multiples of ten, all calculations are made with the utmost simplicity, and the necessity for compound arithmetic, ready reckoners, and complicated tables is dispensed with.

Again, contrast the English system of weighing by grains, drachms, pennyweights, scruples, ounces, pounds, stones, quarters, hundredweights, tons, &c., &c., with the metrical gramme and its simple multiples of ten.

(*See Appendix X.*)

11. Education Simplified by Decimals.

If decimal coins, weights, and measures were adopted, compound arithmetic need no longer be taught in our elementary classes, and in the public elementary schools alone this would save not less than two years' teaching of useless rules. There would thus be more time for the study of foreign languages and other important subjects.

(*See Appendix XI.*)

12. Inconvenience of Change Exaggerated.

A decimal system is so easy to learn that it can be adopted without serious difficulty. One of the best examples is that of Germany. Before the present Empire was formed there were different systems of coinage, weights, and measures in nearly all the States, but under the Empire a uniform decimal coinage, and the

metrical system of weights and measures, were selected and easily adopted. Four years were allowed in which to effect the change, but in little more than one year all difficulties were over.

Among our own Colonies, Ceylon changed from pounds, shillings, and pence to rupees and cents; and it is generally acknowledged that the change has been most beneficial to all classes, and that it was effected without real difficulties of any kind.

It is well known that emigrants to Canada and the United States soon learn the decimal coinage of those countries.

(See Appendix XII.)

13. Decimal System Approved by Chambers of Commerce.

The opinion of commercial men may be considered as almost unanimous in favour of the proposed change, for not only have the seventy-two Chambers of Commerce of the Association of the United Kingdom pronounced themselves repeatedly in this sense, but the four large Chambers which are not members of the Association (Edinburgh, Glasgow, Liverpool, and Manchester), have taken the same ground.

(See Appendix XIII.)

14. Units for Adoption.

The Decimal Association is not pledged to any particular unit for a decimal currency. It recommends the adoption of the metrical system of weights and measures, and as regards the more complex question of coinage, it is thought best to advocate the adoption of a decimal system, in general terms, and to leave Her Majesty's Government to select and decide upon the particular system to be eventually introduced. The desideratum being A DECIMAL SYSTEM FOR COINAGE, FOR WEIGHTS, AND FOR MEASURES.

(See Appendix XIV.)

APPENDICES.

APPENDIX I.

Decimal Notation.

The whole world now stands committed to the decimal notation as the basis of its arithmetic, and when we have to deal with a collection of numbers we invariably arrange them in units, tens, hundreds, or some power of ten. If, for instance, we have to add together 5, 8, and 9, we at once say to ourselves 22, or 2 tens and 2 units. Again, if we have to multiply 6 by 9, we say to ourselves 54, or 5 tens and four units. If we add up several columns of figures, those to the right are treated as units, those in the next column to the left of the first are treated as ten times more than units, and those in the next column to the left, as ten times more than the tens, or one hundred times more than the units, and so on.

This of course is common knowledge, and we merely repeat it because it forms part and parcel of the decimal or ten system we wish to see applied to our coinage, weights, and measures.

APPENDIX II.

Popular Objections to Decimals.

The late Sir George Airy (Astronomer Royal), after a careful consideration of the question, expressed his opinion that the adoption of multiples capable of easy division in our existing system of coinage, practically gives no advantage, though at first it may appear to do so, and he strongly recommended the decimal system as the best. Mr. Babbage also, before he commenced the

construction of his calculating machine, found it necessary to enter into an examination to ascertain whether it would be possible to simplify the mechanism, or accelerate its effects, by the use of an arithmetic arranged on other powers than 10; but after a patient investigation of various bases, particularly those of 8, 12, and 16, he arrived at the conclusion that a system of arithmetic, having the number 10 as its basis, was on the whole the best.

Professor De Morgan remarks:—

"The mere halving of the lowest coin is no disadvantage; it can be done in a decimal system, and will be done when convenient; nothing proposed in the question is either impossible to decimalists or repudiated by them. But it is an abiding delusion of the opponent of decimals that he *will* suppose the decimalist to be under a contract never to use a common fraction. The language of some advocates of decimals is calculated to further this delusion."

APPENDIX III.

Decimal Fractions.

Suppose, for instance, that we write down 555, we know that this means five hundred and fifty five, or in other words that the 5 to the right = 5 muliplied by 1; that the next 5 = 5 multiplied by 10; and that the next = 5 multiplied by 10 times 10, or 5 multiplied by 100. If we now add figures to the right of the units, the first will represent a tenth of the unit, the second a hundredth and the third a thousandth of a unit. In other words, the first figure to the right of the unit is *divided* by 10, the second by 100, the third by a thousand, and so on. If, for instance, we write down 555·555, we shall know that the first figure to the right of the decimal point will represent $^{5}/_{10}$, that the next will represent $^{5}/_{100}$, and the next $^{5}/_{1000}$. In practice, however, it is not necessary to write down the fractions in this way any more than it is to write down $^{50}/_{1}$ or $^{500}/_{1}$ on the other side of the point.

APPENDIX IV.

Simplicity of the Decimal System.

Examples illustrating the rules for placing the Decimal point.

ADDITION.

Add 6.599
120.400
36.570
———
Ans. 163.569

SUBTRACTION.

From 230.2400
Subtract 61.5693
———
Ans. 168.6707

RULE.—Place the decimal points of each set of figures under each other and proceed as in simple arithmetic.

MULTIPLICATION.

Multiply 25.24
by 62.962
———
Ans. 1614.40088

RULE.—Point off in the product as many places of decimals as there are in the multiplier and multiplicand together, and proceed as in simple arithmetic. (In this case there are 5 places of decimals, viz., .24 and .962.)

DIVISION.

Divide 62.426 by 4.25

4.25)62.426(14.6
425
———
1992
1700
———
2926
2550
———
376

RULE.—Point off in the quotient as many places as those in the dividend exceed those in the divisor, and proceed as in simple arithmetic. (In this case the decimal places in the dividend exceed those in the divisor by one)

Again divide 4.25 *by* 62.426

62.426)4.250000(.068
374556
———
504440
499408
———
5032

(In this case the decimal places in the dividend exceed those in the divisor by three. It has been necessary to add 4 ciphers to the dividend to enable the division to be made; it has also been necessary to place one cipher before the decimals in the quotient in order to point off the proper number of decimal places.)

Extracts from Report of the Select Committee on Weights and Measures, July 1862.

"Your Committee have also examined men of science, merchants, manufacturers, and working men belonging to our own country. THEY HAVE SOUGHT FOR ADVOCATES OF THE EXISTING SYSTEM, BUT THEY HAVE FOUND IT DIFFICULT TO DISCOVER THEM. . . . . Omitting many specific anomalies we have no less than ten different systems of Weights and Measures, most of them established by law. Our neighbours the French, AND MANY OTHER NATIONS HAVE ONLY ONE, founded on the Metre, which is a near approximation to the English yard. We find in our own country the following different systems"—&c. . &c. . &c. . &c. . . . . "But it is needless to lead the reader through all these mazes of numerical confusion. . . . It is remarkable that the foreign witnesses concur in stating that no nation which has adopted the Metric system has failed to derive the greatest benefit from such adoption, or, after adoption, has shewn any desire to abandon it."

APPENDIX V.

Decimals applied to Coinage.

The following are the standard units adopted in countries where a decimal system of coinage is used :—

Country.	Coin or token.	Sub-divisions.
America (United States)	Dollar	100 cents
Argentina	Peso	100 cents
Austria	Florin	100 kreuzer
Belgium	Franc	100 centimes
Brazil	Milreis	1000 reis
Canada	Dollar	100 cents
Ceylon	Peso	100 cents
Chili	Dollar	100 cents
China	Tael	100 candaren
Colombia	Rupee	100 cents
Denmark	Krone	100 öre
Egypt	Egyptian pound	100 tariff piastres
France	Franc	100 centimes.
Germany	Mark	100 pfennige
Greece	Drachma	100 lepta
Holland	Florin or Guilder	100 cents
Italy	Lire	100 centesimi
Japan	Yen	100 sens
Mauritius	Rupees	100 cents
Mexico	Peso or Dollar	100 cents
Norway	Krone	100 öre
Peru	Sol	100 cents
Portugal	Milreis	1000 reis
Roumania	Lei	100 centimes
Russia	Rouble	100 kopeck
Spain	Peseta	100 centimos
Sweden	Krona	100 öre
Switzerland	Franc	100 centimes
Turkey	Turkish pound	100 piastres
Uruguay	Dollar	100 cents
Venezuela	Sol	100 cents

APPENDIX VI.

Disadvantages of present System of Currency.

Examples to compare the English and French systems.

	ENGLISH.			FRENCH.
	£	s.	d.	Frs. Cts.
ADDITION.	56	16	8¼	1420.85
	123	19	6½	3099.42
	45	13	9¾	1142.26
	27	11	2¾	689.03
	Ans. 254	1	3¼	*Ans.* 6351.56
	£	s.	d.	Frs. Cts.
SUBTRACTION.	106	8	7¼	2660.75
	82	18	8¾	2091.41
	Ans. 23	9	10½	*Ans.* 569.34

APPENDIX VI.—*Continued.*

MULTIPLICATION.

£	s.	d.	
Multiply 89	17	$11\frac{3}{4}$	*by* 57

57
3
—
4)171
—
12)42 + $\frac{3}{4}$

£	s.	d.
3 + 6 = 0	3	$6\frac{3}{4}$

57
11
—
12)627
—
20)52 + 3
—
2 + 12 = 2 12 3

57
17
—
399
57
—
20)969
—
48 + 9 = 48 9 0

57
89
——
513
456
——
5073

5073	0	0

Ans. £5124 4 $9\frac{3}{4}$

Another method of working:

£	s.	d.	
89	17	$11\frac{3}{4}$	× 57
		5	
449	9	$10\frac{3}{4}$	
		10	
4494	18	$11\frac{1}{2}$	
629	5	$10\frac{1}{4}$	
Ans. £5124	4	$9\frac{3}{4}$	

Frs. Cts.
Multiply 2247.47 *by* 57

2247.47
57
———
1573229
1123735
———
Ans. 128105.79

APPENDIX VI.—*Continued.*

DIVISION.

£ s. d.
Divide 89 17 11¾ *by* 57

57)89(1£
57
—
32
20
——
640
17
——
57)657(11s.
57
——
87
57
——
30
12
——
360
11
——
57)371(6d.
342
——
29
4
——
116
3
——
57)119(2 fgs.
114
——
5

Ans. £1 11 6½d.

Frs. Cts.
Divide 2247.47 *by* 57

F. c.
57)2247.47(39.42
171
——
537
513
——
244
228
——
167
114
——
53

Frs. c.
Ans. 39.42

Extract from the Report of the Select Committee on Decimal Coinage, August 1853.

"With regard to the inconveniences of the existing system, the evidence is clear and decided. That system is shewn to entail a vast amount of unnecessary labour and great liability to error, to render accounts needlessly complicated, to confuse questions of foreign exchanges, and to be otherwise inconvenient.

On the other hand the concurrent testimony of the various witnesses is to the effect that the adoption of a Decimal system would lead to greater accuracy would simplify accounts, would greatly diminish the labour of calculations, (to the extent of one half, and in some cases four-fifths, according to Professor De Morgan who has made the question his especial study), and by facilitating the comparision between the coinage of this country and other countries that have adopted the Decimal system, would tend to the convenience of all those who are engaged in exchange operations, of travellers and others. An important benefit would be derived in several departments of the public

service, and in every branch of industry from the economy of skilled labour which would result from the proposed change; at the same time that the education of the people generally would be much facilitated by the introduction into our schools of a system so directly calculated to render easy the acquirement of arithmetic.

A further evidence of the value of a Decimal system is to be found in the fact of its very general adoption in the different countries of the world, not only in the case of money, but also as respects weights and measures. Your Committee are not aware of any instance in which a country, after adopting the Decimal system, has abandoned it. The tendency, on the contrary, has invariably been in the direction of a further adoption of the system, the most recent instance being that of Portugal, where the mode of reckoning has long been based on the Decimal system, and where a decree has been published within the last few months, providing for the introduction of the French Decimal metrical system of weights and measures. Dr. Bowring explained to your Committee the Decimal system that obtains in the vast empire of China, and produced an instrument, a description of abacus, there called the "Swan-Pan." . . That instrument shows the ease with which a Decimal system may be applied, and the great advantages which it confers, as is, in fact, practically proved by the extraordinary facility with which Chinese boys make any arithmetical calculations . . . . . In conclusion, your Committee, having well weighed the comparative merits of the existing system of coinage and the Decimal system, and the obstacles which must necessarily be met with in passing from one to the other, desire to repeat their decided opinion of the superior advantages of the Decimal system, and to record their conviction that the obstacles referred to, are not of such a nature as to create any doubt of the expediency of introducing that system, so soon as the requisite preparation shall have been made for the purpose, by means of cautious but decisive action on the part of Government. . . . . They believe that the necessary inconvenience attending a transition state will be far more than compensated by the great and permanent benefits which the change will confer upon the public of this country, and of which the advantages will be participated in to a still greater extent by future generations.

APPENDIX VII.

Decimals applied to Weights and Measures.

	Present System.				Decimal System.
ADDITION.	*Add together*				
	Tons	cwt.	qr.	lb.	Kilograms.
	1	19	3	20	*Add together* 2032.72
	3	16	2	16	3901.82
	4	9	1	18	4551.82
	5	11	3	15	5695.91
	Ans. 15	17	3	13	*Ans.* 16182.27
SUBTRACTION.	Tons	cwt.	qr.	lb.	Kilograms.
	From 1	11	2	3	*From* 1605.00
	Subtract	18	3	26	*Subtract* 966.36
	Ans.	12	2	5	*Ans.* 638.64

APPENDIX VII.—*Continued.*

MULTIPLICATION.

	Tons	cwt.	qr.	lb.	
Multiply	16	18	3	21	by 78

By long multiplication:

Tons	cwt.	qr.	lb.
16	18	3	21
20			
338			
4			
1355			
28			
10861			
2710			
37961			
78			
303688			
265727			

28)2960958(105748 qrs.
28
160
140
209
196
135
112
238
224
14 lb.

4)105748

2,0)2643,7

1321,17

	Tons	cwt.	qr.	lb.
Ans.	1321	17	0	14

By short multiplication:

Tons	cwt.	qr.	lb.
16	18	3	21
			10
169	9	1	14
			7
1186	5	2	14
135	11	2	0
Ans. 1321	17	0	14

Kilograms.

Multiply 17255.
by 78

138040
120785

Ans. 1,345,890

APPENDIX VII.—*Continued.*

DIVISION.

Tons cwt. qrs. lbs.
Divide 16 18 3 21 *by* 78

Tons cwt. qrs. lbs.
16 18 3 21
20
—
338
4
——
1355
28
——
10861
2710
————

78)37961(486$\frac{53}{78}$ lb.
312
———
676
624
——
521
468
——
53

28)486(17 qrs.
28
—
206
196
——
10

4)17
—
4,1

Cwt. qrs. lb.
Ans. 4 1 10$\frac{53}{78}$

Divide 1725 Kilograms *by* 78

78)1725(22.11
156
——
165
156
——
90
78
——
120
78
——
42

Ans. 22.11 Kilos.

APPENDIX VIII.

Disadvantages of present Weights and Measures

Give the cost of 215 tons 17 cwts 3 qrs 9 lbs of cast iron at £9 11s. 6d. per ton.

cwt.	Tons. cwt. qrs. lbs.	£ s. d.
20	215 17 3 9	9 11 6
4	20 :	20
80	4317	191
28	4	12
630	17271	2298 pence.
160	28	
2240 lbs. per ton.	138177	
	34542	
	483597	
	2298	
	3868776	
	4352373	
	967194	
	967194	

224-0)111130580-6(496118 pence.

896

2153
2016

1370
1344

265
224

418
224

1940
1792

148

$\frac{148}{224} = \frac{3}{4}$ pence.

12)496118

2-0)4134-3 2

2067 3

Ans. £2067 3s. 2¾d.

APPENDIX VIII.—*(Continued.)*

The same worked by Practice:

215 tons at £9 a ton =	£1935	0	0
,, 10s. = (½ of £1) ...	107	10	0
.. 1s. = (1/10 of 10s.)	10	15	0
.. 6d. = (½ of 1s.) ...	5	7	6
	£2058	12	6

215 tons at £9 11s. 6d. a ton	= £2058	12	6
10 cwt = ½ of 1 ton	4	15	9
5 cwt = ½ of 10 cwt.	2	7	10½
2 cwt. = 1/10 of a ton	0	19	2
2 qrs. = ¼ of 2 cwt.	0	4	9½
1 qr. = ½ of 2 qrs.	0	2	4¾
7 lbs. = ¼ of 1 qr.	0	0	7¼
2 lbs. = 1/14 of 1 qr.	0	0	2
Ans. £2067	3	3	

Note.—The mental calculations involved in this example are not shown.

The same in Decimal form—

Give the cost of 215.8917 tons of cast iron at £9.575 per ton.

Tons.
215.8917
9.575

10794585
15112419
10794585
19430253

2067.1630275

Ans. £2067.163

APPENDIX IX.

Further reasons for adopting Decimal Weights and Measures.

During the last twenty years especially, all the leading European countries have enormously increased their powers of production, and they are not only striving to manufacture all required for their home consumption, but are energetically pushing the sale of their wares in

other countries. In Europe we are chiefly in competition with makers in Belgium, France, Germany, Italy and Switzerland; and the metrical system of weights and measures is not only used in all these countries, but also in nearly all the countries where the competing makers sell their goods.

A very influential deputation representing Chambers of Commerce, Bankers, Merchants and others, was received by the Chancellor of the Exchequer in June, 1887, to urge the adoption of decimal coinage, weights and measures, and among the speakers Mr. W. Crawford (Delegate of the British Chamber of Commerce in Paris) said that after living in Paris for 25 years, as a merchant in English goods, he had been face to face with the practical side of the question, and he could testify to the very great value of a purely decimal system. He had always to reduce the complicated English system to the French one before he could sell any of his goods there. Manufacturers in England had done a great deal to bring the machinery of their factories to the highest pitch of productiveness, but they had done very little to improve the mental machinery by which they made up their costs and prices, and this should no longer be neglected in these days of keen competition. Another experienced merchant in Paris (Mr. Th. Pilter) complains of the great inconvenience he is put to in offering English machines to French buyers. Supposing, for instance, that he is asked to quote for an English implement the price of which is £13 in London, and of which the gross weight is 4 cwts., 3 qrs., 8 lbs., and the nett weight 3 cwts., 2 qrs., 24 lbs. He must first convert the £13 into francs, and then the gross weight into 245 kilos for the transport charges, and the nett weight into 188 kilos for the duties. These calculations take time and are liable to errors, whereas by the decimal system it would be as follows:—

	Frs. C.
Price in London.	325.00
Carriage on 245 kilos, @ 5 frs.	12.25
Duties on 188 kilos @ 5 frs.	9.40
Price delivered	346.65

Extract from Foreign Office Report, No. 180, on subjects of general and commercial interest, Italy, dated August 1st, 1890.

"Manufacturers state that the exertions of German travellers to push their trade, are indefatigable, and, as they are always anxious to comply with the desires of their customers, they are often successful, while British firms, instead of travellers, forward catalogues, which are of little or no use, especially as they are for the most part drawn up in English, and *prices are quoted in English weights and measures.*"

APPENDIX X.—The Metrical System.

Tables of English and Metrical Systems of Weights and Measures.

ENGLISH SYSTEM.

Avoirdupois Weight.

drachms.	ozs.	lbs.	qrs.	cwts.	ton.
1 =	.0625 =	.0039 =	.000139 =	.000035 =	.00000174
16 =	1 =	.0625 =	.00223 =	.000558 =	.000028
256 =	16 =	1 =	.0357 =	.00893 =	.000447
7168 =	448 =	28 =	1. =	.25 =	.0125
28672 =	1792 =	112 =	4. =	1. =	.05
573440 =	35840 =	2240 =	80. =	20. =	1.

Troy Weight.

grains.	dwts.	ozs.	lb.
1 =	.04167 =	.00208 =	.0001736
24 =	1. =	.05 =	.004167
480	20. =	1. =	.0833
5760 =	240. =	12. =	1.

175 lbs troy = 144 lbs. avoirdupois.
lbs. avoirdupois × 1.2153 = lbs. troy.
lbs. troy ... × .82286 = lbs. avoirdupois.

Long Measure.

ins.	feet.	yards.	fath.	poles.	furl.	mile.
1 =	.083 =	.02778 =	.0139 =	.005 =	.000126 =	.0000158
12 =	1 =	.333 =	.1667 =	.0606 =	.00151 =	.0001894
36 =	3 =	1 =	.5 =	.182 =	.00454 =	.000568
72 =	6 =	2 =	1 =	.364 =	.0091 =	.001136
198 =	16½ =	5½ =	2¾ =	1 =	.025 =	.003125
7920 =	660 =	220 =	110 =	40 =	1. =	.125
63360 =	5280 =	1760 =	880 =	320 =	8. =	1.

METRICAL SYSTEM.

*Weights.

	Grammes.
Milligramme	.001
Centigramme	.01
Decigramme	.1
Gramme	1.
Decagramme	10.
Hectogramme	100.
Kilogramme	1,000.
Myriagramme	10,000.
Quintal	100,000.
Millier or Bar	1,000,000.

*Long Measure.

	Metres.
Millimetre	.001
Centimetre	.01
Decimetre	.1
Metre	1.
Decametre	10.
Hectometre	100.
Kilometre	1,000.
Myriametre	10,000.

**For ordinary purposes, only the gramme, kilogramme, and quintal are used for weights; and the millimetre, centimetre, metre, and kilometre for long measure.*

APPENDIX X.—**The Metrical System** (*Continued*)

Comparison between English and Metrical Systems of Weights and Measures.

Square Measure.

ins.	feet.	yards.	perches.	roods.	acre.
1	=.00694	=.000772	=.0000255	=.00000064	=.000000159
144	= 1	=.111	=.00367	=.0000918	=.000023
1296	= 9	= 1	=.0331	=.000826	=.0002062
39204	= 272¼	= 30¼	= 1	=.025	=.00625
1568160	=10890	=1210	= 40	=1	=.25
6272640	=43560	=4840	=160	=4	=1

Cubic Measure.

ins.	feet	yard.
1	=.0005788	=.000002144
1728	= 1	= .03704
46656	=27	=1

Measure of Capacity.

pints.	gall.	peck.	bushel.	quarter.	wey.	last.	cub. ft.
1	=.125	=.0625	=.01562	=.00195	=.00039	=.000195	=.020051
8	= 1	=.5	=.125	=.0156	=.00312	=.00156	=.16046
16	= 2	= 1	=.25	=.03125	=.00625	=.00312	=.32092
64	= 8	= 4	= 1	=.125	=.025	=.0125	=1.28367
512	= 64	= 32	= 8	=1	=.2	=.1	= 10.269
2560	= 320	=160	= 40	=5	=1	=.5	= 51.347
5120	= 540	=320	= 80	=10	=2	=1	=102.69

*Square Measure.

	Square metres.
Milliare	.1
Centiare†	1.
Deciare	10.
Are	100.
Decare	1,000.
Hectare	10,000.

† *One Square Metre.*

*Cubic Measure.

	Cubic Metres
Millistere	.001
Centistere	.01
Decistere	.1
Stere, or cubic metre	1.
Decastere	10.
Hectostere	100.

Measure of Capacity.

	Litres.
Millilitre	.001
Centilitre	.01
Decilitre	.1
Litre*	1.
Decalitre	10.
Hectolitre	100.
Kilolitre†	1,000.
Myrialitre	10,000.

**Litre=Millistere*

†*Kilolitre=cubic metre.*

**The terms square cubic metres, &c., are generally used instead of "ares," (except "hectares") "steres," and their multiples.*

APPENDIX X *(continued)*

The foregoing tables have been extracted from a practical book which has passed through twenty three editions, and has been very largely used for calculations of all kinds during the last thirty years.

The comparison of these tables is not intended to indicate that the equivalents given under the English system are necessary in all ordinary calculations, but rather to shew what has been a want in practice under the cumbrous English system, and to bring out clearly that such equivalents are quite unnecessary under a perfect decimal system.

The metrical system has been selected for comparison, because it is the most perfect decimal system at present existing; in fact, under that system, all weights and measures are reduced to two items, with their decimal multiples, viz: the GRAMME and the METRE; and in practice many of the terms set down in the metrical tables are very seldom used. For example, in Long Measure the KILOMETRE, METRE, CENTIMETRE, and MILLIMETRE are the only terms ordinarily used, and in weights, the GRAMME, KILOGRAMME, QUINTAL and TONNE.

The measure of Capacity is practically the same as the Cubic Measure; for the Kilolitre is a cubic metre, and the only change necessary for assimilation is a simple alteration in the position of the decimal point.

The comparison does not bring out all the disadvantages of the English system, for it omits many of the weights and measures that are the outcome of the system, such as Apothecaries' weight, Wine and Beer measures, Birmingham Wire gauges of sorts, plate gauges, &c., &c. Moreover, the English system, as shewn above, is incapable of minute accuracy; for example, anything below an inch has to be expressed in fractions, or decimals, whereas in the metrical system, the millimetre is about the twenty-fifth part of an inch; and the milligramme is about the sixty-sixth part of a grain troy.

The following is an Extract from the Report of the International Conference on Weights and Measures, Paris, 1867.

"The multiplicity of degrees in the metric scale is not of a nature to give any trouble or to produce any confusion. As these degrees merge the one into the other with great facility, custom reduces the number of them in general use. Thus in France, in practice, the measure of length is calculated by metres and centimetres: the hectometre and decimetre are little used."

APPENDIX XI.

Education simplified by Decimals.

In a Memorial of the Decimal Association presented to the School Board for London in June, 1890, it was pointed out that under the Code of the Education Department the standards of examination in the elementary subjects include the following for arithmetic :—

STANDARD III.—The four simple rules, with long division. Multiplication and pence tables, and addition and subtraction of money.

STANDARD IV.—Compound rules (money) and reduction of common weights and measures.

The tables to be learned include :—

Weight.—The ton, cwt, quarter, stone, pound, ounce and drachm.
Length.—The mile, furlong, rod or pole, chain, yard, foot and inch.
Area.—The square mile, acre, rood, square pole or perch, the square yard, foot and inch (Boys only).
Capacity.—The quarter, bushel, peck, gallon, quart and pint.

STANDARD V.—Practice, bills of parcels, rule of three, and addition and subtraction of proper fractions with denominators not exceeding 12.

STANDARD VI.—Fractions, vulgar and decimal; simple proportion, and simple interest.

STANDARD VII.—Average, percentages, and stocks.

It is usual to devote one hour each day to arithmetic, and each scholar is supposed to be about one year in each standard. It was therefore assumed that not less than *two years*' teaching in arithmetic would be saved if it were no longer necessary to learn the compound rules above referred to.

Extract from the Report of the Select Committee on Weights and Measures, July, 1862.

"Economy of time in education is one of the beneficial results of the Metric system. While the study of English weights and measures is laborious and repulsive to both teacher and pupil, any one can easily master the Metric system. 'Comparing the English system of calculation with the decimal,' says M. Lorsont, 'I think the difficulty of the English is as great as it would be to make a calculation in the old Roman figures.' The Metric system is soon learned. 'Any person,' says Mr. Fellows, 'in a quarter or in half an hour would be able to master the whole Metric system.' The time which the use of a Decimal system would save in education has been generally stated (on the authority of school masters) to be at least a year. Mr. Mumford, late certificated master of the British school at Highgate, describes the readiness and interest with which children have acquired it. Dr. Ihne, of the University of Bonn, conductor of a large school at Liverpool, finds his pupils, especially foreign boys, 'repelled and annoyed' by the English system of weights and measures, and his teachers also. He states that it requires considerably more time to learn, so that a boy is prevented from ever attaining the higher position of knowledge, which he might otherwise reach, by this preliminary barrier of arithmetic.

'The waste of time,' says the Rev. Alfred Barrett, (a clergyman extensively engaged in education,) 'to junior pupils in learning the tables of weights and measures is immense.' He describes the work of education in the French Military academies as 'much higher and much more forward than ours,' and traces the cause to the time of juvenile pupils being lost in their wanderings through the mazes of our arithmetical system. That eminent mathematician, Professor De Morgan, thinks that 'the whole time devoted to arithmetical education might, by adopting the Decimal system, be reduced by one-half, or probably more.' 'Its adoption,' says Dr. Farr, (Superintendent of the Statistical Department in General Register Office), 'would get rid of all compound rules of arithmetic; it would make calculations simple and mechanical. Decimal logarithms are calculated and printed by machinery; with the vulgar fractions of our common arithmetic this could not be done.'"

APPENDIX XII.

Inconvenience of change exaggerated.

As Ceylon changed from pounds, shillings and pence to rupees and cents in 1869, it is instructive to note what occurred. The opposition to the proposed change was very great, and a Committee appointed by Government, to consider the question, rejected it. Eventually the opposition was overcome, and only six weeks after the change was effected, the Financial Secretary of the Public Works Department (Mr. Ralph Tatham) wrote that:—

"All the necessary changes in the accounts, stamps, tolls, &c., have been effected without the slightest hitch or difficulty of any kind; in fact the change is so little felt that people have ceased to talk about it."

After 4½ years' experience, the Manager of the Chartered Mercantile Bank, Colombo, (Mr. James Robertson) wrote:—

"I sat on the Commission appointed by Sir Hercules Robinson to consider the currency question, and it was my opinion at the time that should we make the rupee the legal currency, we ought to follow India in the smaller denominations. However, I have long since changed my views on this point, as practical experience has proved to me the advantage of the decimal sub-division of the rupee in the facility with which calculations are made, and the increased simplicity of book-keeping; and I will add that I think this is the general view of the case."

After 16 years' experience of the working of the decimal system, a Member of the Government Council (Hon. W. E. Sharpe) wrote:—

"I never heard of any—the slightest—hitch or trouble being experienced by any department or individual, public or private, official or native, in working the decimal system in Ceylon. It was quite marvellous to me to see, on my return there in 1873, that every one had fallen into the new system; and one's bazaar" [marketing] "accounts were as simple as they had before been complicated."

Extract from the Report of the Select Committee on Decimal Coinage, August 1853.

"Your Committee have also taken evidence as to the difficulty experienced on occasions when the coinage of any country has been changed, and would especially refer to the cases of the United States and of Ireland. In the former country the old system of pounds, shillings, and pence, has been entirely superseded by the Decimal system of dollars and cents, and no inconvenience appears to have attended the change. . . . In the case of Ireland, where thirteen Irish pence made an English shilling, for which twelve English pence were substituted, a prejudice was originally felt on the part of the poorer classes, in consequence of their believing that as they only got twelve pence for a shilling where they formerly received thirteen, they sustained a loss of a penny in every shilling. They soon found from experience, however, that the injury was imaginary."

Extract from the evidence of Professor De Morgan before the Select Committee on Weights and Measures :—June 1862.

"I may give another instance to show the comparative power of the Government over the coinage. I have here a list of the coins actually current in England at the time of the Restoration. The number of gold coins was upwards of 50, and they were passing at all kinds of odd pence. There was the crown of Elizabeth, passing at 5s. 11d. The Government raised these coins by proclamation, in 1660. The crown of Elizabeth increased in value from 5s. 11d. to 6s. 4d. The Salute was increased from 7s. 11d. to 8s. 5d. There was no complaint throughout the country, and no resistance, but all was very satisfactorily done."

Extract from the Report of the Select Committee on Weights and Measures, July 1862.

"Your Committee examined on this part of the subject more than one working man. There is abundant testimony to the ease with which working men aquire the Metric system. Mr. Dickson already referred to, says: 'In the works I carry on' (at Dunkirk) 'I employ about 1,000 persons. I have had frequently a great many overseers from Scotland: they come not knowing the French Language, far less the weights and measures or the money, but they very soon get acquainted with the Metric System.' Mr. Richard Wyse has been in the employment of Mr. Brassey as a mechanic 25 years: he has been engaged on railways in France, Belgium, and Savoy. He states that he very soon understood the Metric scale and found it much easier to comprehend than the English scale of yards, feet, and inches. 'The English workman,' he says, 'gets the weights very quickly.' He is asked, 'How long do you think it would take them?' His answer is 'A fortnight or a month at furthest. All the workmen I ever had to do with prefer the French method to the English.'"

Extract from the address of Sir William (now Lord) Armstrong, at the British Association, 1864.

"I can speak from personal experience of the superiority of decimal measurement in all cases where accuracy is required in mechanical construction. In the Elswick works, as well as in some other large establishments of the same description, the inch is adopted as the unit, and all fractional parts are expressed in decimals. No difficulty has been experienced in habituating the workmen to the use of this method, and it has greatly contributed to the precision of workmanship. The inch, however, is too small a unit, and it would be advantageous to substitute the metre, if general concurrence could be obtained."

Extract from the Report of the International Conference on Weights, Measures and Coins. Paris, June 1867.

"It has been objected that it is difficult to induce workmen and merchants to substitute new measures for those which they have been accustomed to from their infancy. The slow manner with which the change has been made in countries which have accepted the Metric system seems to justify such objection. Still it must be remarked that among the nations which have been the first to introduce it, and even amongst ths least enlightened people, the assimilation of new measures has become in time quite complete. *If some of the old names are still left in use* the value of the new measures is not less fixed in the mind: *no confusion is produced by the remembrance of the prohibited measures.* . . . . . When we present therefore to a mind accustomed to the old divisions a simplification so beneficial we have no reason to fear any serious objection other than that of custom. Now the experience of many nations has shewn that custom does not resist the evidence of practical utility and the double action of education and law."

Extract from the Report of the International Statistical Congress on the subject of International Weights, Measures and Coins. Berlin, 1863.

Replies to the Question:—**"Was the change to a Decimal System of Weights, Measures and Coins unpopular?"**

FRANCE:—AMBASSADOR:—"Popular with all save a few."
M. DELESSERT:—"Yes, with the lower classes at first, but not at present."
M. CHEVALIER:—"No."
COMMERCIAL AGENT:—"No."
M. ST. HILAIRE:—"Yes, with the ignorant classes."

ITALY:—H.M. MINISTER, Turin:—"Unpopular with the lower classes at the outset, but they are gradually becoming familiar with the new system."
INTENDANT OF THE MINT:—"It caused no popular disturbance, and was received generally with ease."

BELGIUM:—H.M. MINISTER at Brussels:—"None of the changes appear to have been unpopular."
T. BARING, Esq., M.P.:—"The country was already accustomed to the new system. . . There was no commotion."

SWITZERLAND:—FEDERAL COUNCIL:—"There was at first an aversion on the part of those Cantons bordering on Germany to use the French system, but it has gone off, and the people are well satisfied."
M. M. MARCUARD & CIE, BERNE:—"Popular, because it was well understood."

NETHERLANDS:—Sir J. H. TURING, Bart., Consul, Rotterdam:—"The change was accomplished without unpopularity or uneasiness."

AMSTERDAM:—J. ANNESLEY, Consul:—"Rather unpopular with unlettered and old: but this feeling has been transitory. The Dutch are for the most part opposed to innovations."

GREECE:—H.M. MINISTER, Athens:—"The change was decidedly popular."

UNITED STATES:—DIRECTOR OF U. S. MINT:—"The change was popular with all classes, but notwithstanding the habits of the people were very slowly supplanted, although the advantages of the new system were unanimously conceded."

EDWARD EVERETT, Esq.—"The simplicity and beauty of the Decimal system were immediately felt by all; the change not being compulsory, could have aggrieved no one."

APPENDIX XIII.

Chambers of Commerce.

The Chambers of Commerce throughout the Kingdom have for a long time agitated for the introduction of a Decimal System, and at the annual meetings of the Associated Chambers (consisting of 72 Chambers of Commerce), resolutions in favour of this object have been passed with great regularity. At the last meeting in March, 1890, the Association resolved "that a deputation be appointed to wait upon the vice-President of the Committee of Council for Education to urge that steps may at once be taken to make the study of the decimal system of coinage and weights and measures a compulsory subject in all public elementary schools." Effect was given to this on June 16th, when an influential deputation waited on Sir W. Hart-Dyke, who acknowledged the importance of the body which the deputation represented, and of the subject under consideration. He said that he had long been in favour of such a system and that they had his most cordial sympathy as far as the general policy was concerned. He thought his Department would not be able to carry out the suggestions of the delegates before the system was legally authorised, but that bearing in mind that the education given to the children must not only be the best but the one most immediately suitable to their welfare, progress, and success in life, he would be glad if in the future he was enabled in any degree to forward the objects the deputation had in view.

In addition to the deputation to the Chancellor of the Exchequer in 1887, and the spontaneous action just mentioned, there are 19 Chambers of Commerce who actively support the Decimal Association with their membership. The London Chamber of Commerce has particularly identified itself with the movement by inaugurating the Decimal Association, and by actively co-operating with it.

APPENDIX XIV.

Units for adoption.

Extract from the Report of the Decimal Coinage Commission, 5th April, 1859.

"12.—That duly weighing the foregoing considerations, it does not appear desirable under existing circumstances, while our *weights and measures remain as at present*, and so long as the principle on which their simplification ought to be founded is undetermined, to disturb the established habits of the people with regard to the coins now in use, by a partial attempt to introduce any new principle into the *coinage alone*."

[*NOTE.—Although this extract is quoted, it should be understood that the Decimal Association will gladly adopt a decimal system of coinage simultaneously with, or before or after the adoption of the metrical system of weights and measures.*]